Economics 466–Introduction to Econometrics–Exam II

Answer Key–More Preliminary Version

1. (a) This required a little care as the formula used to provide the correct interpretation changed from Model (1) to Model (3) as the dependent variable was transformed from one to another. For Model (1), where the dependent variable is in natural logarithms, the correct interpretation is: houses in areas along the Charles river raise the median value of homes by $100[e^{0.22} - 1] = 24.6\%$, *ceteris paribus*. In Model (3) where the dependent variable is in level form the correct interpretation is: houses in areas along the Charles river raise the median value of homes by \$5,520.00, *ceteris paribus*.

   (b) This was a trick question depending upon how you read it. You just needed to take the appropriate partial derivative. The effect of NOX on median home values in Model (1) is $\frac{\partial LMDEV}{\partial NOX} = \frac{\partial MDEV}{\partial NOX} \cdot \frac{1}{MDEV}$, so $\frac{\partial MDEV}{\partial NOX} = \frac{\partial LMDEV}{\partial NOX} \cdot MDEV = (2.52 - 6.16 \cdot NOX) \cdot MDEV$. In Model (2) the effect is $\frac{\partial LMDEV}{\partial NOX} \cdot MDEV = (-3.94 - 4.86 \cdot NOX - 0.18 \cdot CRIME) \cdot MDEV$.

   (c) Here you needed the formula for the change point of a quadratic. In Model (1), the optimal level of NOX, NOX^*, was: $NOX^* = \frac{-2.52}{-6.16} = 0.409$, while in Model (3) we have: $NOX^* = \frac{-84.09}{-179.90} = 0.467$. There is not much difference in the optimal levels regardless if we use the log-level or the level model to estimate the relationship.

   (d) Models (1) and (3) need to have $\bar{R}^2$ calculated while Model (2) needs only R^2 determined.

   - Model (1):$\bar{R}^2 = 1 - (1 - 0.525)\frac{505}{500} = 0.5203$
   - Model (2):$R^2 = 1 - (1 - 0.396)\frac{501}{505} = 0.4008$
   - Model (3):$\bar{R}^2 = 1 - (1 - 0.430)\frac{505}{500} = 0.4243$

(e) This question was tough and required care. The first thing to remember is that the coefficient on NOX does not have a *ceteris paribus* interpretation. If we write out the partial effect of NOX in Model (2). We have $\frac{\partial LMDEV}{\partial NOX} = -3.94 - 4.86 \cdot NOX - 0.18 \cdot CRIME$, and the coefficient for NOX is the intercept in this formula. However, you need to put this answer into a % interpretation as changes in logarithmic units are meaningless. This suggests that the interpretation for the coefficient should be the **constant** percentage change $(100 \cdot (e^{-3.94} - 1) = -98.0552\%)$ in median housing prices given a change in NOX in the air (regardless of the particular value of NOX or $CRIME$). This number is quite high, but remember, we have not accounted for the level of NOX or $CRIME$ so this value is not troublesome.

(f) This question is tricky because unless you realized that none of the models are nested it is useless to base your decision on the R^2s of the three models. Model (1) has the highest $\bar{R}^2$ of the three models and is the one that should be selected. It also includes measures of crime, education, and view, which are important qualities that home buyers look for so we want them in any model of housing prices, which provides an argument against Model (2). The only difference between Model (1) and Model (3) is the transformation of the dependent variable. With the same regressors the log-level model has a higher $\bar{R}^2$ which is good, but since the dependent variable has been transformed between the two models $\bar{R}^2$ cannot be used to select a better fitting model since taking logarithms reduces the variation in a variable. Clearly Model (1) is supreme to Model (2) but further investigation is needed to select between Models (1) and (3).

2. This question required some thought. At a first glance many of you probably thought there were a lot of typos, but the goal was to write things down wrong in order to see if you had your intuition straight.

   (a) **Incorrect:** R^2 **cannot** be used to select between nonnested models. Adding more variables will automatically raise the R^2 of the corresponding model and a nonnested pair of models where one model has more covariates will most likely have a higher R^2, which does not provide us the proper information to select between models. Keep in mind that $\bar{R}^2$ penalizes models that add variables that do no help explain variation, which is perfect for nonnested models where one puts the regressors in level form in one model and in logarithmic form in another model.

(b) **Incorrect:** Heteroscedasticity robust standard errors can be bigger or smaller than regular standard errors and there is no intuition for which should be true, it needs to be considered on a dataset to dataset basis.

(c) **Correct:** Since the 0-32 scale is just 32 times the 0-1 scale, the coefficient on the dummy variable will be scaled down by 32 and so an increase from 0 to 32 (which is 32) will cancel the scaling down of the coefficient and the 0-1 interpretation will be found.

(d) **Incorrect:** If the goal is to learn about the population parameters, and the population model is linear, then taking logarithms will not help you towards your goal. You should only take logarithms to reduce heteroscedasticity if you are concerned with statistical significance of coefficients in a given model.

(e) **Incorrect:** Heteroscedasticity means that the **conditional** variance of the errors is nonconstant.

(f) **Incorrect:** The dummy variable trap is when you include a dummy variable for each group **and** there is an intercept in the model. Just having a dummy variable for each group with no intercept is fine, but interpretation is a little bit trickier.

(g) **Correct:** Even if one uses the wrong form of the scedastic function the WLS estimators of the slope coefficients are still unbiased because the first four assumptions of the Gauss-Markov Theorem hold true.

3. (a) To test for heteroscedasticity one could use the Breusch-Pagan test or the White test. (You could also have listed the Special version of the White test)

   (b) I would not use a test for heteroscedasticity because it would not be present. Only x and w appear in my model and so the conditional variance of my errors is constant with respect to them.

   (c) Equation (2) allows me to test **absolutely** nothing. Regressing the residuals on the covariates of the original model is pointless since OLS creates the residuals in such a way that they are **uncorrelated** with any of the covariates.

   (d) Knowing the form of heteroscedasticity is better than not knowing the form because if the wrong form is used to create the weights used for WLS, heteroscedasticity will still be present and my standard errors obtained from WLS will be incorrect.

4. **Bonus Question**: For the Breusch-Pagan test, the common criticism is that it models the scedastic function exactly the same way as the population model, which is unlikely to hold in practice. The White test's downfall is that it uses too many degrees of freedom when testing for heteroscedasticity. (You would have needed to mention something on the Special White test if you listed it in 3(a) above)